A Study on the Economic Impact of Bariatric Surgery

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Objective: To evaluate the private third-party payer return on investment for bariatric surgery in the United States.

Study Design: Morbidly obese patients aged 18 years or older were identified in an employer claims database of more than 5 million beneficiaries (1999-2005) using *International Classification of Diseases, Ninth Revision, Clinical Modification* code 278.01. Each of 3651 patients who underwent bariatric surgery during this period was matched to a control subject who was morbidly obese and never underwent bariatric surgery. Bariatric surgery patients and controls were matched based on patient demographics, selected comorbidities, and costs.

Methods: Total healthcare costs for bariatric surgery patients and their controls were recorded for 6 months before surgery through the end of their continuous enrollment. To account for potential differences in patient characteristics, we calculated the cost differential by estimating a Tobit model. A return on investment was estimated from the resulting coefficients. Costs were inflation adjusted to 2005 US dollars using the Consumer Price Index for Medical Care, and the cost savings were discounted by 3.07%, the 3-month Treasury bill rate during the same period.

Results: The mean bariatric surgery investment ranged from approximately $17,000 to $26,000. After controlling for observable patient characteristics, we estimated all costs to have been recouped within 2 years for laparoscopic surgery patients and within 4 years for open surgery patients.

Conclusions: Downstream savings associated with bariatric surgery are estimated to offset the initial costs in 2 to 4 years. Randomized or quasiexperimental studies would be useful to confirm this conclusion, as unobserved characteristics may influence the decision to undergo surgery and cannot be controlled for in this analysis.

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The prevalence of obesity among the US adult population has increased steadily to reach one third of the US adult population.[1] More alarming yet, the trend in morbid obesity outpaces that of nonmorbid obesity. From 2000 through 2005, the US obesity rate increased by 24%, while the rate of morbid obesity (body mass index [BMI], calculated as weight in kilograms divided by height in meters squared ≥40) grew by 50%, and the rate of patients with a BMI exceeding 50 grew by 75%.[2,3] This trend in morbid obesity results in increased healthcare utilization and costs, as healthcare costs for the morbidly obese are 81% above those for the nonobese population and 47% above costs for the non–morbidly obese population.[4,5]

Morbid obesity is associated with a myriad of serious comorbid conditions, including hypertension, type 2 diabetes mellitus, dyslipidemia, osteoarthritis, and gallbladder disease.[6,7] Bariatric surgery has been demonstrated to be an effective weight-loss alternative for the morbidly obese[8-10] and is associated with marked resolution of comorbidities.[9] Other studies[11-13] have found similar results, with reductions in morbidity, cardiovascular risk, healthcare utilization, and costs in bariatric surgery patients compared with control subjects. Although most of the current literature examines health benefits associated with bariatric surgery,[14] studies have also documented quality-of-life improvements,[15,16] length-of-life increases,[17-19] and reduced work loss[20] associated with bariatric surgery.

Despite the extensive literature on the clinical effects of bariatric surgery, little research has been published on the economic impact of the procedure. This represents a growing gap in the literature as the clinical outcomes become better known and the procedure becomes more commonplace (>170,000 surgical procedures in 2005), while its economic costs or benefits remain unclear.[21] The present analysis is unique in its use of actual patient-level cost data for 3651 patients who underwent the procedure. The resulting return on investment is calculated based on up to 5 years of postoperative cost data.

This study quantifies the effect of bariatric surgery on direct medical costs. We focus on the time required for third-party payers to recover the initial investment associated with bariatric surgery (ie, the return on investment).[8] Using the Ingenix private insurer claims database and a matched cohort method and focusing only on costs incurred and saved by the private insurer, we build on findings of a

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previous study[20] that suggested a 9-year period to recoup the cost of bariatric surgery. We further examine changes in return on investment over time as bariatric surgery techniques have improved and focus on laparoscopic surgery outcomes.[22] This analysis should help evaluate the cost-benefit implications of bariatric surgery.

METHODS

Data

We used a privately insured administrative claims database containing medical and drug claims from 1999 through 2005 covering more than 5 million lives from 31 large companies that provided extensive health insurance coverage, including mental health. These companies have operations nationwide in a broad array of industries and job classifications (eg, financial services, manufacturing, telecommunications, energy, and food and beverage). The data contain deidentified information on patients' demographics (eg, age and sex) and monthly enrollment history, as well as medical and pharmacy claims. Specifically, patients' utilization of medical services is recorded with the date of service, place of service, associated diagnoses, performed procedures, billed charges, and actual amount of payments. Patients' pharmacy claims contain prescribed medications identified by National Drug Code, the date a prescription was filled, days of supply, quantity, and actual payment amount. The study sample for this analysis included claimants having a diagnosis of morbid obesity (*International Classification of Diseases, Ninth Revision, Clinical Modification* code 278.01). Patients 18 years or older who underwent bariatric surgery were identified using Health Care Financing Administration Common Procedural Coding System and *Current Procedural Terminology* codes 43644, 43645, 43842, 43843, 43845, 43846, 43847, S2085, S2082, and S2083. Of these procedures, 73% were gastric restrictions with bypass (codes 43845, 43846, and 43847), 11% were gastric restrictions without bypass (codes 43842 and 43843), 12% were laparoscopic surgical procedures with bypass (codes 43644, 43645, and S2085), and 4% were laparoscopic surgical procedures without bypass (codes S2082 and S2083).

Analysis

The initial date of bariatric surgery was defined as the index date for the relevant patient, as well as his or her control. All claimants in the study sample were required to have at least 6 months of continuous enrollment before the index date and 1 month following the index date.

Because patients with a morbid obesity claim may be sicker, on average, than patients with no such claim recorded, surgery-eligible controls (morbidly obese patients with no bariatric surgery procedure code) were matched to bariatric surgery patients based on age group, sex, state of residence, comorbidities, and 5-month presurgery direct costs (months −6 to −2, excluding month −1 immediately before surgery, which is often characterized by increased costs associated with preparation for surgery). Each bariatric surgery patient was matched to a specific control drawn from the morbidly obese control population that never underwent bariatric surgery.

For each bariatric surgery patient, a control was considered a match if (1) the control's age was within the same 10-year age range as that of the bariatric surgery patient, (2) the control was of the same sex, (3) the control resided in the same state as the bariatric surgery patient, (4) the control had the same 10 comorbidities as the bariatric surgery patient (**Table 1**), and (5) the control's healthcare costs fell within 1 SD of the cumulative costs (during months −6 to −2) incurred by the bariatric surgery patient. The matching of bariatric surgery patients with their controls is performed based on 10 comorbidities, although findings in a review of the existing literature[23] and the guidelines of the American Society for Bariatric Surgery[24] suggest that 18 comorbidities could cause imbalance between the 2 samples. However, not every patient could be matched on the demographics and on all 18 comorbidities because patients with the corresponding combination of comorbidities may not be observed in the control group. Hence, patients were matched to controls using a subset of the following 10 comorbidities: asthma, coronary artery disease, diabetes mellitus, dyslipidemia, gallstones, gastroesophageal reflux, hypertension, nonalcoholic steatohepatitis or nonalcoholic fatty liver disease, sleep apnea, and urinary incontinence. Multivariate analysis was used to account for the remaining 8 comorbidities, thereby addressing any remaining imbalance across matched samples. These 8 comorbidities are breast cancer, congestive heart failure, lymphedema, major depression, osteoarthritis, polycystic ovary syndrome, pseudotumor cerebri, and venous stasis or leg ulcers.

Because calculating a return on investment requires a comparison of costs for the bariatric surgery and control patients during multiple years, 2 adjustments were made. First, costs were inflation adjusted to 2005 US dollars using the Consumer Price Index for Medical Care because a dollar spent today would purchase more goods and services than a dollar spent in 2 years (as long as inflation is positive). Second, cost savings were discounted by a 3.07% interest rate, the mean return on a 3-month Treasury bill, because a dollar saved today would, if invested in a risk-free Treasury bill, be worth more than a dollar in 2 years (roughly $1.06 at the stated rate). However, the shorter the time horizon to recoup costs, the less effect discounting will have on the estimated return on investment. The multivariate analysis modeled normalized monthly costs as a function of bariatric surgery interacting with discrete indicators of time from surgery. A positive coefficient indicates that costs incurred by the bariatric surgery patients are higher; a negative coefficient indicates that costs are lower relative to their controls. Therefore, positive coefficients indicate incremental third-party payer costs associated with bariatric surgery (the "investment"), and negative coefficients indicate savings from bariatric surgery (the "return"). The return on investment calculations combine these estimates to determine the number of months necessary for cumulative savings associated with improved comorbidity outcomes following surgery to cover the initial investments. The point estimates are reported with 95% confidence intervals (CIs). Indicator variables in 6-month increments are included to allow for nonlinear savings. In addition to the indicator variables, the multivariate model controlled for age and the 8 comorbidities already mentioned. The comorbidities were tracked at 3-month intervals to record changes in prevalence.

Healthcare costs cannot be negative, rendering ordinary least squares analysis biased and inefficient.[25] Therefore, we estimated a maximum likelihood Tobit model with a cluster option to account for panel-level heterogeneity[26] to reflect the truncated normal distribution. A sensitivity analysis was conducted using an interval model, which yielded similar results. We calculated the cost differential by estimating the model on the pooled population (patients and controls) and using the coefficient on the variable interacting bariatric surgery with the relevant time period. Based on this coeffi-

Table 1. Baseline Characteristics of Bariatric Surgery Patients and Matched Surgery-eligible Control Subjects

Baseline Characteristic[a]	Bariatric Surgery Patients (n = 3651)	Surgery-eligible Control Subjects (n = 3651)
Demographics		
Age at index date, mean, y	43.8	44.1
Female sex, %	86.0	86.0
Age group, y, %		
18-30	11.1	11.1
31-40	27.0	27.0
41-50	32.2	32.2
51-64	29.7	29.7
Year of index date, %		
1999	0.5	0.5
2000	2.4	2.4
2001	8.2	8.2
2002	18.3	18.3
2003	29.1	29.1
2004	21.2	21.2
2005	20.3	20.3
Comorbidity profile, %		
Matched comorbidity		
Asthma	3.9	3.9
Coronary artery disease	1.9	1.9
Diabetes mellitus	18.4	18.4
Dyslipidemia	19.0	19.0
Gallstones	0.9	0.9
Gastroesophageal reflux	9.7	9.7
Hypertension	37.0	37.0
Nonalcoholic steatohepatitis or nonalcoholic fatty liver disease	0.4	0.4
Sleep apnea	13.5	13.5
Urinary incontinence	0.1	0.1
Nonmatched comorbidity		
Breast cancer	0.5	0.8
Congestive heart failure	1.0	1.3
Lymphedema	0.3	0.3
Major depression	6.5	5.5[b]
Osteoarthritis	9.7	7.3[c]
Polycystic ovary syndrome	1.0	0.9
Pseudotumor cerebri	0.3	0.2
Venous stasis or leg ulcers	0.1	0.1

(Continued)

Table 1. Baseline Characteristics of Bariatric Surgery Patients and Matched Surgery-eligible Control Subjects *(Continued)*

Baseline Characteristic[a]	Bariatric Surgery Patients (n = 3651)	Surgery-eligible Control Subjects (n = 3651)
Healthcare service utilization, %		
Inpatient visit	4.5	4.9
Emergency department visit	10.8	12.4[b]
Outpatient hospital visit	58.0	45.8[c]
Office visit	93.5	84.0[c]
Healthcare costs, mean (SD), $		
Prescription drug	668 (1019)	663 (988)
Medical service	1775 (2555)	1480 (2510)[c]
Total	**2443** (2864)	**2143** (2797)[c]

[a]Baseline characteristics are measured during the 6-month preindex period except for healthcare costs and utilization, which do not include the month before surgery and cover 5 months of care. For bariatric surgery patients, the index date is the first date recorded for bariatric surgery; for surgery-eligible control subjects, the index date is the same as that of the matched patient. Bariatric surgery patients and surgery-eligible controls were matched on the following 10 comorbidities: asthma, coronary artery disease, diabetes mellitus, dyslipidemia, gallstones, gastroesophageal reflux, hypertension, nonalcoholic steatohepatitis or nonalcoholic fatty liver disease, sleep apnea, and urinary incontinence.
[b]$P < .05$.
[c]$P < .01$.

cient, a return on investment is calculated by offsetting the initial bariatric investment against incremental cost savings for bariatric surgery patients following surgery.

Overall results across all bariatric surgical procedures are reported using the complete time series available from 1999 through 2005. For open surgical procedures, results are further reported separately for patients who received their surgical procedure from 1999 through 2002 and for patients who received their surgical procedure from 2003 through 2005. This tests our clinical experience of shorter lengths of stay and improved outcomes associated in part with the development of centers of excellence in the later years, which may in turn shorten the estimated return on investment relative to the earlier period. This approach cannot be used for laparoscopic surgery because a code specific to that type of surgery did not exist until 2004. Hence, we report results for patients who underwent laparoscopic surgery from 2004 through 2005 separately. All estimations were performed using statistical software (Intercooled STATA 9.2 [StataCorp LP, College Station, Texas] and SAS 9.1 [SAS Institute, Cary, North Carolina]).

RESULTS

Table 1 compares bariatric surgery patients and their controls at baseline after matching on age group, sex, costs, state of residence, and 10 comorbidities. The sample is predominantly female (86%), with a mean age of 44 years. More than one third of the sample had hypertension, and close to 20% had dyslipidemia or diabetes mellitus. Major depression and osteoarthritis are the only 2 comorbidities with statistically different prevalences across groups. Both comorbidities are included as control variables in the multivariate analysis. Both study groups have similar prescription drug costs. Bariatric surgery patients have somewhat higher baseline medical service costs (20%) and total healthcare costs (14%). The absence of any statistically significant difference in weight-loss medication use or in visits to nutritionists suggests that these differences are not driven by differences in presurgery reimbursable weight-loss efforts. Patients were observed for 6 months before surgery and for a mean of 17 months and 18 months following the index date for the bariatric surgery group and the control group, respectively.

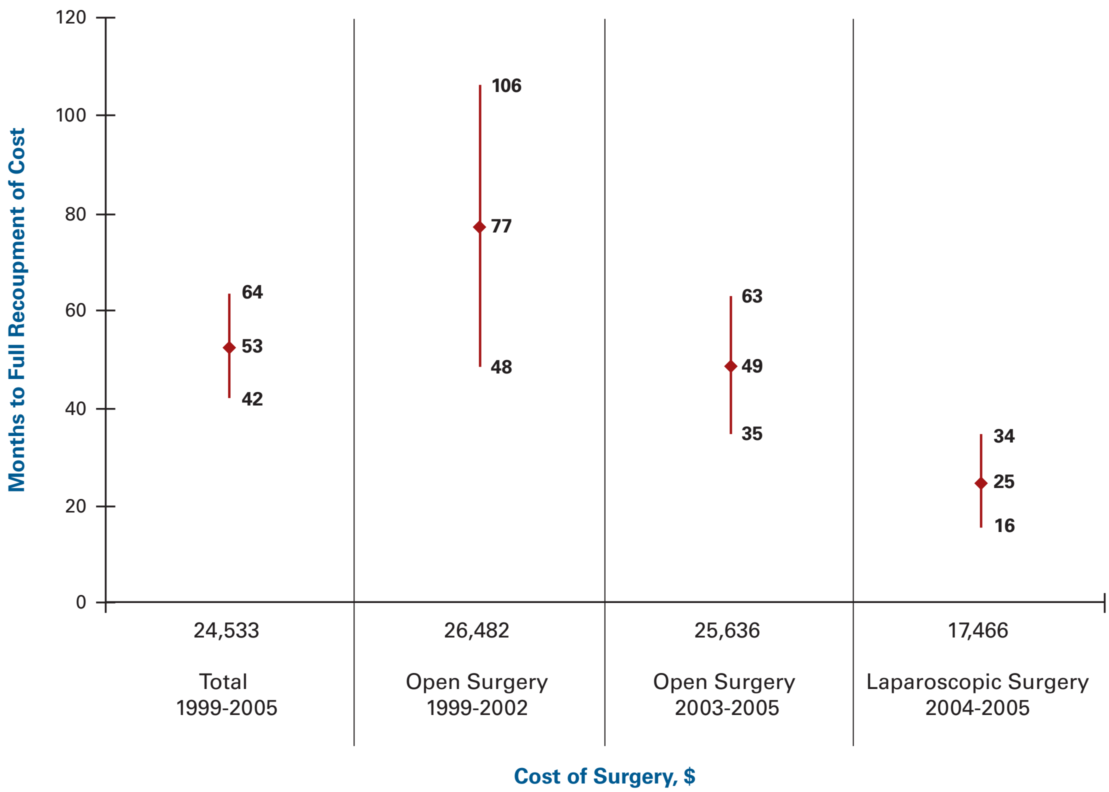
Multivariate regression analysis results summarized in Table 2 demonstrate total incremental costs of approximately $24,500 for all types of bariatric surgery combined, $26,000 for open surgery, and $17,000 for laparoscopic surgery during the period from 1 month before surgery to 2 months following surgery. The total incremental cost is the sum of costs incurred in the month before the surgery, costs incurred in surgery, and costs incurred in the first 2 months following surgery. Starting at month 3, cost savings associated with the bariatric surgery patients start accruing. One and a half years after surgery, monthly savings associated with bariatric surgery reach more than $500 for the whole sample and $400 (1999-2002) to $600 (2003-2005) for open surgery depending on the period ($P < .01$). Monthly savings associated with laparoscopic bariatric surgery reach more than $900 as early as 13 months following surgery ($P < .01$). The **Figure** shows the estimated return on investment for the 4 models given in Table 2. Based on the data available and on an assumption of constant savings after 19 months, we find that (for the combined sample) total surgery costs are fully recovered after 53 months (95% CI, –42 to 64 months). Costs of open surgery performed between 1999 and 2002 are fully recovered after 77 months (95% CI, –48 to 106 months), and, as expected, costs

Table 2. Multivariate Regression Analysis of Total Monthly Costs of Bariatric Surgery (Dependent Variable Minus Total Monthly Costs) Estimated Using a Tobit Model[a]

	Total	Open Surgery		Laparoscopic Surgery
Variable	1999-2005 (n = 7302)	1999-2002 (n = 2346)	2003-2005 (n = 3914)	2004-2005 (n = 1042)
Presurgery, $				
Months –6 to –2	148.04[b]	–84.99	274.51[c]	312.87[b]
Month before surgery	1815.04[b]	1814.84[b]	1971.79[b]	1278.99[b]
Time of surgery	19,118.01[b]	20,325.78[b]	19,900.61[b]	14,468.50[b]
Postsurgery, $				
Months 1 to 2	1799.78[b]	2170.51[b]	1881.62[b]	859.40[b]
Months 3 to 6	–49.4[b]	176.50	–145.16	–161.27
Months 7 to 12	–272.85[b]	13.75	–402.77[b]	–496.55[b]
Months 13 to 18	–436.67[b]	–207.14[b]	–537.07[b]	–926.23[b]
Months 19 and longer	–544.69[b]	–399.86[b]	–590.68[b]	—
No. of observations	221,483	96,963	106,638	17,882

[a]The model controls for age, breast cancer, congestive heart failure, lymphedema, major depression, osteoarthritis, polycystic ovary syndrome, pseudotumor cerebri, and venous stasis or leg ulcers. For laparoscopic surgery, a likelihood ratio test showed that the coefficients for 13 to 18 months and for 19 months and longer are statistically similar, so a single coefficient is reported. For all other models, a likelihood ratio test was performed to see if grouping the data past 19 months was significantly different from continuing with 6-month increments. All *P* values were statistically nonsignificant.
[b]$P < .01$.
[c]$P < .05$.

Figure. Return on Investment for Bariatric Surgery by Types of Surgery and Different Periods



Take-away Points

The rate of bariatric surgery use has increased in the past decade to more than 170,000 surgical procedures per year in the United States.

- The initial investment for bariatric surgery is approximately $26,000 for open surgery and $17,000 for laparoscopic surgery.
- After taking into account age, sex, and comorbidities, the initial investment is returned within 4 years for patients who undergo open surgery and within 2 years for patients who undergo laparoscopic surgery.
- Even ignoring potential quality-of-life and length-of-life benefits, as well as disability and work loss, third-party payers can rely on bariatric surgery paying for itself through decreased comorbidities within 2 to 4 years.

of open surgery performed between 2003 and 2005 are recovered after 49 months (95% CI, –35 to 63 months). Costs associated with laparoscopic surgery are fully recovered after 25 months (95% CI, –16 to 34 months). These returns on investment result from reductions in prescription drug costs, physician visit costs, and hospital costs (including emergency department visits and inpatient and outpatient visits). The reduced costs are associated with multiple major diagnosis categories, including diabetes mellitus, coronary artery disease, hypertension, and sleep apnea.

DISCUSSION

Bariatric surgery is an effective treatment for morbid obesity. However, payer coverage for these procedures has lagged because of cost concerns. This analysis demonstrates that payers can expect significant cost savings to start accruing after 25 months for patients undergoing laparoscopic bariatric surgery. The study also shows that, while bariatric surgery costs took more than 6 years to be fully recovered as recently as 2002, this interval has been reduced to just over 2 years in 2005 for laparoscopic bariatric surgery. These improvements in return on investment can be attributed to surgical experience, improved technology, and dedicated facilities.[27] Although striking, the short return on investment associated with bariatric surgery is consistent with the well-demonstrated immediate and long-lasting decrease in a myriad of comorbid conditions, including, for example, diabetes mellitus, coronary artery disease, hypertension, and sleep apnea.[11-19,23] The cost reductions observed in this analysis mirror the comorbidity reductions in these disease areas in terms of prescription drug use, hospital visits, and physician visits. Although no systematic data have yet been published to our knowledge, the growing prevalence of "centers of excellence" may also have contributed to this downward trend in costs through improved outcomes and follow-up.[28] We have not examined the cause of the cost advantage associated with laparoscopic bariatric surgery. Our experiences as laparoscopic (SAS) and open (HB) surgeons suggest that it may result from open procedures' being disproportionately performed in the earlier years. At centers performing open and laparoscopic bariatric surgery, patients with higher BMIs and higher comorbidity rates may also be more likely to undergo open surgery.[29] Alternatively, at centers performing laparoscopic bariatric surgery on all morbidly obese patients irrespective of BMI, the lower cost associated with laparoscopic surgery may be the result of reduced trauma, shorter length of stay, or lower levels of wound complications.[8]

Any increases in copayment beyond those incurred by patients in our data (75% of patients had no copayment) would further shorten the period necessary for payers to fully recover their costs. For example, a 25% patient copayment on claims reimbursed would reduce the estimated return on investment period for full recovery from 49 months to approximately 32 months for open surgery and from 25 months to approximately 18 months for laparoscopic surgery. These recovery periods ignore the quality-of-life benefits and reduced work loss associated with weight loss resulting from bariatric surgery.[15,16]

To our knowledge, only 1 other study has assessed the economic benefits of bariatric surgery. In a simulation study, Finkelstein and Brown[20] reported that a 5- to 10-year period was necessary to fully recover costs associated with bariatric surgery. Using real data, our study documents improvement in results relative to the simulation conducted by Finkelstein and Brown. They relied on survey data (2000-2001 Medical Expenditure Panel Survey) to estimate savings; our analysis relies on actual claims records during a 6-year period. Our analysis omits absenteeism costs, while Finkelstein and Brown assumed reduced absenteeism for bariatric surgery patients. Furthermore, the costs of bariatric surgery were assumed by Finkelstein and Brown based on prior literature, whereas we estimated these costs directly from recorded claims. Similarly, reduced costs associated with surgery are calculated directly from claims rather than estimated from various assumptions about surgery-associated weight loss. Despite these significant methodological differences, our estimate of 4 to 9 years for full cost recovery in the early period between 1999 and 2002 is consistent with the 9 years estimated by Finkelstein and Brown.

This study is based on a large insurance claims database that includes detailed information on costs and comorbidities. However, BMI (a potentially useful measure of bariatric surgery eligibility and outcomes) is unavailable. Although this is a limitation of our analysis, surgery-eligible controls were matched to bariatric surgery patients along multiple demographic factors and 18 comorbidities that are likely to be correlated with BMI. Most important, the bariatric surgery patients and the surgery-eligible controls were diagnosed as having morbid obesity, which requires the patient to have a BMI of 40 or higher. The reliability of the cost-savings estimates in our analyses depends in part on the accuracy of our matching process. We matched the bariatric surgery patients with their respective controls on multiple baseline characteristics, including age, sex, total presurgery medical costs, and up to 10 comorbid conditions. We imposed the strict criterion of an exact match on the comorbidities but also confirmed our findings using propensity score matching. We find that the exact match results in a more balanced sample of patients and controls, although it is limited to 10 comorbidities rather than 18 comorbidities selected. Controlling for the 8 nonmatched comorbidities through regression analysis yields similar results, suggesting that few imbalances remain in the sample. Nevertheless, unobserved characteristics unrelated to baseline costs, age, sex, and the selected comorbidities may influence the decision for surgery, introducing a potential bias in the analysis.

Another limitation of our analysis is that the sample of patients observed shrinks as the period elapsed since the index date increases. In particular, the breakeven point estimated for open surgery is dependent on the assumption of constant cost savings from month 19 onward, while the average patient is observed for 17 months. As a result, the CIs estimated around the point estimates widen as the sample size of observed patients decreases over time. Further research based on data during longer periods would be useful to assess the longer-term bariatric surgery return on investment and to confirm the cost savings. Nevertheless, this analysis presents new evidence about the return on investment associated with bariatric surgery during a postsurgery period of 2 to 5 years depending on the date and type of bariatric surgery. Further research on the return on investment for the subgroup of patients with diabetes mellitus might be a useful avenue of research given recent clinical findings for that subset of the population.[17-19,30]

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REFERENCES

1. National Institutes of Health Web site. Statistics related to overweight and obesity. July 1996. National Institutes of Health publication 96-4158. http://www.niddk.nih.gov/health/nutrit/pubs/statobes.htm. Accessed June 12, 2007. Accessed August 21, 2008.

2. RAND Corporation Web site. Obesity and disability: the shape of things to come. 2007. http://www.rand.org/pubs/research_briefs/2007/RAND_RB9043-1.pdf. Accessed June 12, 2007.

3. Sturm R. Increases in morbid obesity in the USA: 2000-2005. *Public Health.* 2007;121(7):492-496.

4. Flegal KM, Carroll MD, Oden CL. Prevalence and trends in obesity among US adults, 1999-2000. *JAMA.* 2002;288(14):1723-1727.

5. Arterburn DE, Maciejewski ML, Tsevat J. Impact of morbid obesity on medical expenditures in adults. *Int J Obes (Lond).* 2005;29(3):334-339.

6. National Heart, Lung, and Blood Institute Web site. The practical guide: identification, evaluation, and treatment of overweight and obesity in adults. October 2000. http://www.nhlbi.nih.gov/guidelines/obesity/prctgd_c.pdf. Accessed June 12, 2007.

7. Hensrud DD, Klein S. Extreme obesity: a new medical crisis in the United States. *Mayo Clin Proc.* 2006;81(10)(suppl):S5-S10.

8. Zhao Y, Encinosa W. *Bariatric Surgery Utilization and Outcomes in 1998 and 2004.* Rockville, MD: Agency for Healthcare Research and Quality; January 2007. Statistical brief 23.

9. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis [published correction appears in *JAMA.* 2005;293(14):1728]. *JAMA.* 2004;292(14):1724-1737.

10. Kendrick ML, Dakin GF. Surgical approaches to obesity. *Mayo Clin Proc.* 2006;81(10)(suppl):S18-S24.

11. Christou NV, Sampalis JS, Liberman M, et al. Surgery decreases long-term mortality, morbidity and health care use in morbidly obese patients. *Ann Surg.* 2004;240(3):416-424.

12. Bastis JA, Romero-Corral A, Collazo-Clavell ML, et al. Effect of weight loss on predicted cardiovascular risk: change in cardiac risk after bariatric surgery. *Obesity.* 2007;15(3):772-783.

13. Kushner RF, Noble CA. Long-term outcome of bariatric surgery: an interim analysis. *Mayo Clin Proc.* 2006;81(10)(suppl):S46-S51.

14. Cawley J, Prinz T, Beane S. Health insurance claims data as a means of assessing reduction in co-morbidities 6 months after bariatric surgery. *Obes Surg.* 2006;16(7):852-858.

15. Dymek MP, le Grange D, Neven K, Alverdy J. Quality of life after gastric bypass surgery: a cross-sectional study. *Obes Res.* 2002;10(11):1135-1142.

16. Dixon JB, Dixon ME, O'Brien PE. Quality of life after Lap-Band placement: influence of time, weight loss, and comorbidities. *Obes Res.* 2001;9(11):713-721.

17. Adams TD, Gress RE, Smith SC, et al. Long-term mortality after gastric bypass surgery. *N Engl J Med.* 2007;357(8):753-761.

18. Bray GA. The missing link: lose weight, live longer. *N Engl J Med.* 2007;357(8):818-820.

19. Sjostrom L, Narbro K, Sjostrom CD, et al; Swedish Obese Subjects Study. Effects of bariatric surgery on mortality in Swedish obese subjects. *N Engl J Med.* 2007;357(8):741-752.

20. Finkelstein EA, Brown DS. A cost-benefit simulation model of coverage for bariatric surgery among full-time employees. *Am J Manag Care.* 2005;11(10):641-646.

21. American Society for Bariatric Surgery Web site. Medicare expands coverage for lifesaving obesity surgery: private insurers expected to follow suit. February 21, 2006. http://www.asbs.org/html/about/ncd_release.html. Accessed September 21, 2007.

22. Schauer PR, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. *Ann Surg.* 2000;232(4):515-529.

23. Buchwald H. Obesity comorbidities. In: Buchwald H, Pories W, Cowan GM Jr, eds. *Surgical Management of Obesity.* Philadelphia, PA: Elsevier Inc; 2007:37-44.

24. American Society for Bariatric Surgery Web site. Guidelines for -granting privileges in bariatric surgery. http://www.asbs.org/html/guidelines.html. Accessed August 15, 2007.

25. Buntin MB, Zaslavsky AM. Too much ado about two-part models and transformation? Comparing methods of modeling Medicare expenditures. *J Health Econ.* 2004;23(3):525-542.

26. Maddala GS. *Limited-Dependent and Qualitative Variables in Econometrics (Econometric Society Monographs).* New York, NY: Cambridge University Press; 1986:149-194.

27. Santry HP, Gillen DL, Lauderdale DS. Trends in bariatric surgical procedures. *JAMA.* 2005;294(15):1909-1917.

28. Bradley DW, Sharma BK. Centers of excellence in bariatric surgery: design, implementation, and one-year outcomes. *Surg Obes Relat Dis.* 2006;2(5):513-517.

29. Buchwald H, Estok R, Fahrbach K, Banel D, Sledge I. Trends in mortality in bariatric surgery: a systematic review and meta-analysis. *Surgery.* 2007;142(4):621-635.

30. Dixon JB, O'Brien PE, Playfair J, et al. Adjustable gastric banding and conventional therapy for type 2 diabetes. *JAMA.* 2008;299(3):316-323. ■